

OSTEOLOGY OF PALAEORNIS, WITH OTHER NOTES ON  
THE GENUS.

By R. W. SHUFELDT.

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(Plates XXXIX–XLI.)

One of the most abundant parrots of India is *Palaeornis torquatus*, or the Ring-parrot, so named for the reason that in the adult a ring or collar forms a part of the plumage of the neck. It is a species long known to many in the Indian Empire, where it is represented as the vahana or “vehicle” of Kama, one of the gods of the Hindus. Kama corresponds to our Cupid, or rather the classic Eros, symbolising Love. These birds—for there are several species of them—were supposed to be known to the Greeks and Romans; but they were not considered as a sub-family of parrots until so founded by Vigors in 1825, who named the *Palaeornithinae* to contain them.

Linnaeus described one species, naming it *Palaeornis alexandri*, believing it to be the bird that was referred to by Onesicritus, one of the historians of Alexander the Great.

They are generally gregarious in habit, and *Palaeornis torquatus*, the species mentioned above, is often found in flocks numbering several thousands.

There are about twenty-five species of these parrots, and they occur principally in the Orient, though others inhabit Africa. They are noisy birds, with harsh notes given with great vehemence. Many like them as pets, and occasionally one may be taught to say a few words, while as a rule they are gentle and tractable. *Palaeornis exul*, A. Newton, is supposed to be extinct; it formerly inhabited the Island of Rodriguez. The African species is *Palaeornis docilis*, and it is found in Sudan, Equatorial Africa, and in Abyssinia.

Garrod, the British ornithotomist, examined a number of species of the *Palaeornithidae*, and found that in them the *ambiens muscle* was absent, and that there were two carotids, except in the genus *Cacatua*.

Garrod worked out the main stem of the *Psittaci*, and stated that “Each of the two secondary branches persists as the *Palaeornithinae* and the

*Pyrrhurinae* respectively, they both branching dichotomously in an exactly similar manner, the former giving rise to the *Stringopinae* and the especially modified *Cacatua cristata* and *C. sulphurea*, the other to the similarly modified *Platycecinæ* and *Chrysotinae*." \* In another place Garrod stated that "the presence of a gall-bladder in the *Cacatuinae* will have to be included among the characteristic peculiarities of this sub-family. At the same time its persistence in them is in favour of the view that the *Palaeornithinae*, as restricted by me, are but little different from the ancestral parrots, and the *Cacatuinae* still less so. The primitive parrots must have possessed a gall-bladder, because we know that this organ is present in the *Cacatuinae*, and consequently was not absent in the primitive species, as the probability that it should have been independently developed a second time is infinitely little." †

Late in the autumn of 1914 Mr. Edward S. Schmid, of Washington, D.C., presented me with a specimen of a parrot that had died in captivity, the history of which was not known to him. Before removing the skin of this bird, I made, by the aid of my camera and tints, the figure here reproduced in Plate XXXIX, which is exactly half natural size. No notes were made upon the soft parts, while upon the other hand I obtained a perfect skeleton for description.

Not being sure of the species, I took the skin to Mr. J. H. Riley, of the Division of Birds of the U.S. National Museum, for examination, and from him I received, in a day or so, the following letter, for which he has my sincere thanks. It is dated at the Smithsonian Institution, November 5, 1914, and the essential part of it reads as follows: "The parrot left by you to be identified is either *Palaeornis torquata* or *Palaeornis docilis*. These two species are practically identical in plumage, and only differ in size, *P. docilis* being slightly smaller. As the skin left by you lacks the bill and the wing bones have been taken out, it is hard to tell with any certainty to which species to assign it, but am inclined to place it with *P. docilis*. *P. torquata* is Indian and Malayan, while *P. docilis* is typical African in distribution." ‡ I may say that the superior mandible in the specimen was

\* Garrod, A. H.: "On Some Points in the Anatomy of the Parrots which bear on the Classification of the Suborder." P.Z.S., 1874, pp. 586-598, Plates LXX and LXXI. The part quoted occurs on p. 595.

† Garrod, A. H.: "Note on the Absence or Presence of a Gall-Bladder in the Family of the Parrots." P.Z.S., 1877, p. 793.

‡ Newton, in the article "Parrot" in the Ninth Edition of the "Encyclopædia Britannica" (vol. xviii, p. 322), says, in a footnote, that "It is right to state, however, that the African examples of this bird are said to be distinguishable from the Asiatic by their somewhat shorter wings and weaker bill, and hence they are considered by some authorities to form a distinct species or subspecies, *P. docilis*; but in thus regarding them the difference of locality seems to have influenced opinion, and without that difference they would scarcely have been separated, for in many other groups of birds distinctions so slight are regarded as barely evidence of local races."

of a brilliant vermilion red, with the apex tipped with black; the lower mandible was entirely black. Irides very pale straw yellow; feet pale flesh colour. The character and colour of the plumage is well shown in the plates.

#### THE SKELETON.

(Plates XL and XLI, figs. 1-8.)

*Introduction.*—Up to the present time the osteology of the Parrots or *Psittaci* has, as compared with that of other birds, been touched upon but very lightly. Neither Garrod nor Forbes gave the subject any very serious attention. The first-named ornithotomist, as we know, devoted himself principally to certain peculiarities of the muscles and arterial system in those birds, as he did in the case of other representatives of the class *Aves*. He gave some attention, however, to the *furcula* as well as to the oil-gland. That this was the case was much deplored by the late Alfred Newton, F.R.S., who said in regard to it, in his article "Parrot" in the Ninth Edition of the *Encyclopaedia Britannica*, when referring to what little Garrod had done even with the *furcula*: "But except as regards the last character he unfortunately almost wholly neglected the rest of the skeleton, looking upon such osteological features as the formation of an orbital ring and peculiarities of the atlas as 'of minor importance,' an estimate to which nearly every anatomist will demur; for, though undoubtedly the characters afforded by blood-vessels and muscles are useful in default of osteological characters, it is obvious that these last, drawn from the very framework of any vertebrate's structure, cannot be inferior in value to the former."\*

Huxley, in his time-honoured and admirable paper "On the Classification of Birds" (*P.Z.S.*, 1867, pp. 465, 466), gives some of the salient characters on the skeleton of the *Psittacomorphae*, which are very useful for the purposes of classification, but not sufficiently extensive for all other purposes. They are excellent for group definition, while not exact enough for taxo-

\* "Indeed," continues Professor Newton in the same place, "the investigations of Professor A. Milne-Edwards (Ann. Sc. Nat. Geologie, ser. 5, vi, pp. 91-111; viii, pp. 145-156) on the bones of the head in various Psittacine forms make it clear that these alone present features of much significance, and if his investigations had not been carried on for a special object, but had been extended to other parts of the skeleton, there is little doubt that they would have removed some of the greatest difficulties. The one osteological character to which Garrod trusted—namely, the condition of the *furcula*—cannot be said to contribute much towards a safe basis of classification. That it is wholly absent in some genera of parrots had long been known, but its imperfect ossification, it appears, is not attended in some cases by any diminution of volant powers, which tends to show that it is an unimportant character, an inference confirmed by the fact that it is found wanting in genera placed geographically so far apart that the loss must have had in some of them an independent origin" (*loc. cit.*, p. 323).

nomical use in the case of families and genera. Moreover, when Professor Huxley says that "the lachrymal and the post-orbital bend towards one another, and frequently unite below the orbit" (p. 465), he makes a statement, as will be shown further on in the present paper, that does not hold true for all parrots.

Many years ago, I published an account of the skeleton of our now nearly extinct Carolina parrot, and later, a somewhat more extensive contribution on the osteology of a number of species of the family, with an account of the skeleton of the famous Owl Parrot included in the same article.\* Shortly after these appeared, the late Professor St. George Mivart kindly sent me reprints of some of his own work on the osteology of this group, and these papers are now at hand.†

Then we have for consultation the classical works on the osteology of these birds by E. Blanchard, Sir Richard Owen, Max Fürbringer, and a few others.

*The Skull.*—As in all of the *Psittaci* thus far examined by me, the skull, when viewed from above (Plate XL, fig. 2), is smooth and hemiglobular with respect to the vault or cranial region, while it is markedly very broad and flat between the sharp superior margins of the orbits. Between this area and the base of the broadly rounded and much decurved superior mandible, there is found the long, transverse "cranio-facial hinge," here represented by a fine, slit-like groove, perpendicular to the long axis of the cranium. Beyond this line a short distance are the rather large, subcircular *nasal apertures*, either one facing forwards, upwards and outwards. Their margins are sharp, and projecting from within one of these openings there is a free little process of bone. This is also seen to be present in *Ara chloroptera* and other *Psittaci*, and in adult birds it is somewhat difficult to say from which bone of the face it is developed. In *Palaeornis*, however, it would appear to be a *free*, shell-like ossification, held in place by the surrounding membrane in the upper region of the rhinal chamber. In no parrot is it connected with the anterior part of the mesethmoid, while in the big macaws it seems to fuse almost indistinguishably in the adult with

\* Shufeldt, R. W.: "Osteology of the *Conurus carolinensis*." Journ. of Anat. and Phys., London, April, 1886, vol. xx, Plates X and XI, pp. 407-425. "Osteology of the *Psittaci*." Annals of the Carnegie Museum, Pittsburg, Pa., 1902, vol. i, Plates XXI-XXIV, pp. 399-421.

† Mivart, St. George, F.R.S.: "On the Hyoid Bone of Certain Parrots." P.Z.S. Lond., March 5, 1895, pp. 162-174, figs. 1-6. This is an excellent paper with instructive illustrations. In it Professor Mivart said: "That the Parrots should have a tongue-bone of exceptional form is, of course, only what was to be expected from the exceptional form of their tongue as a whole" (p. 163). "The Skeleton of *Lorius flavopalliat* compared with that of *Psittacus erithacus*" (Part I). P.Z.S., Lond., April 2, 1895, pp. 312-337, figs. 1-22. "On the Hyoid Bones of *Nestor meridionalis* and *Nanodes discolor*." P.Z.S., Lond., February 4, 1896, pp. 236-340, figs. 1 and 2.

the mesial aspect of the nasal and the maxillo-palatine of the same side. This is a large, fused, osseous mass in the skull of a macaw, while in *Palaeornis* these ossifications appear to be quite free and scroll-like. They appear to take the place of *turbinals*, and apparently have a similar function of increasing the osseous surface for the nasal mucous membrane.

The sharp apex of the superior mandible, as in all parrots I believe, points directly downward, and is trihedral in form. In the macaws (*Ara*) the external narial apertures are extremely small for the size of the skull, they not having the diameter of those openings as seen in the skull of a specimen of *Amazona leucocephala* in my collection, the skull of which latter is not one-third the size of that of the former species. Then, too, in the macaws they are far apart as in *Ara severa*, a skeleton of which I have in my own collection, as well as in other species of that genus.

At the base of the cranium the *foramen magnum* is seen to be circular in outline as it is in most parrots. In *Ara* it may occasionally approach the cordate form, but in a specimen in my collection it is quite circular. The temporal wings of the exoccipitals in *Palaeornis* are only fairly well developed, not as much so as in *Amazona*, and very much less than in *Ara chloroptera*, where they are very conspicuous, thin, projecting plates of bone standing out far behind the cranial base. They are not quite so prominent in some of the smaller species of macaws. These latter birds also have the presphenoid strongly compressed transversely, with its lower border sharp and thin. It is also sharp in *Palaeornis*, but it at once becomes broader above; and in all *Psittaci* thus far examined by me, the *interorbital septum* is thick and never perforated by a central or other vacuity.

Either *pterygoid* is a long, straight, delicate bar, and, as in other parrots, these bones meet each other anteriorly, while the articulation with either quadrate is on a small, subcircular facet, situated at the infero-distal end of the single, convex, transversely flattened facet for the mandible. I may say here that the *orbital* process of a quadrate is, as usual in these birds, a pointed and much aborted spine.

As usual, the *palatines* are broad, plate-like bones, with their extensive mesial surfaces nearly parallel to each other. Their form has been previously described by me in my above-cited papers for *Conurus* and other species, and they agree in this African species in their main characters. It is to be noted, however, in *Palaeornis* that anteriorly the *mesethmoid* projects much further beyond the interpalatine articulation than it does in *Ara* and other species.

With respect to the morphology and arrangement of the *ethmoid*, *maxillo-palatines*, and other bones forming the walls and enclosures of the rhinal chamber, *Palaeornis docilis* agrees essentially with other *Psittaci*, apart from a few generic departures that pertain especially to it as a species. It lacks the peculiar, wing-like extensions of the maxillo-palatines seen in the

big macaws, as well as the plate-like median partition found in those and other representatives of the group, which partition fulfils in part the place of a true nasal septum. Possibly this septum may partially be derived from either nasal, and this is a point I cannot settle with exactitude without seeing the skull of an immature specimen.

All parrots have the osseous roof of the mouth entire, with its posterior boundary a sharp, transverse margin or edge. This area is invariably concaved, the outer borders (*tomia*) being sharp. In *Palaeornis* this edge, on either side, presents a distinct notch, as shown in Plate XL, fig. 1. This notch is also found in this locality in the skulls of the birds in the genus *Amazona* and many others; but it is usually absent in macaws—indeed, entirely so in *Ara chloroptera*. On the other hand, in *Cacatua* the posterior two-thirds of the osseous tomial margin of the superior mandible is horizontal (parallel to the plane of the superficies of the frontal region of the skull), while the anterior third is perpendicular to this, the two edges forming a right angle between them.

Turning to the lateral view, we are to note that *Palaeornis* forms no exception to the general rule for the *Psittaci* in possessing a nearly straight, long, and rather stout *quadrato-jugal bar*. Posteriorly, it articulates in a little pit on a special elevation on the side of the curiously formed quadrate in these birds, while anteriorly, it abruptly merges into the infero-posterior angle of the upper osseous mandible, in the locality of the maxillo-palatine mass. Immediately before doing this, this rod exhibits a very slight disposition to enlarge somewhat, evidenced in a compression from above downwards.

Interest, however, centres on this lateral view of the skull of *Palaeornis*, as in the case of other *Psittaci*, in the form of the orbit, and the arrangement of the bones constituting its limiting periphery. Parrots, almost without exception, have the boundary of an orbit wonderfully circular in outline, while its margins are, for the most part, thin and sharp.

As is usually the rule throughout the group, the orbit is entirely surrounded by bone. This is effected in *Palaeornis docilis* by the slender, narrow, and transversely compressed, infero-posteriorly extending process of the lacrymal bone uniformly curving backwards to touch, but not to fuse with, the anterior apex of the squamosal process on the lateral aspect of the cranium (Plate XL, fig. 1). This is interesting from the fact that this lower boundary of the orbit in this species of parrot is formed almost entirely by the backward extension of the lacrymal bone; that it is the *squamosal* process and not the post-frontal that it seeks in order to complete the ring; and that that process is in no way especially elongated to meet it.

In the skull of the different species of *Ara*, in so far as I have examined them, the bounding orbital ring is very complete, its lower half being of uniform width, with sharp edges above and below, while posteriorly it completely fuses with the *post-frontal process*, and in such a manner, in a skull

of *Ara chloroptera* at hand, that no line of sutural union is visible, while the anterior portion of the process has conformed itself entirely to the form of the encircling bone. I am inclined to believe, however, that, as in *Palaeornis*, the lacrymal bone here, too, extended backward to meet the post-frontal apophysis, rather than the latter extended forward to meet the lacrymal. Now, in *Amazona leucocephala* the lacrymal bone again completes the circle, meeting and fusing with the anterior end of the *post-frontal process*; but as it passes the apex of the squamosal process below, it develops a slight elevation on its lower edge, which is directed toward the apex of the squamosal process as though it were making an effort to reach it.

In the cockatoos (*Cacatua leadbeateri*) this union is not only accomplished, but it is so extensive that a bony plate is formed in this locality, stretching between and fusing with the *two* lateral processes of the side of the cranium—that is, the post-frontal and squamosal apophyses—to such an extent that a large foramen exists between them, into which leads the *crotaphyte fossa* of the same side of the skull. As the *crotaphyte fossa* harbours the temporal muscle, the tendon of which is inserted into the mandible,\* this plate forms a very effective osseous protection to that muscle, for which there seems to be no sufficient reason apparent.

Thus we see that the encirclement of the orbit in parrots differs considerably in the different genera; but this in no way explains why these birds should require that their orbits be entirely surrounded by bone and as extensively so as in the big macaws. That there is some reason for it there can be no doubt, or else the lacrymal bone would not take upon itself such a supreme effort to form that osseous surrounding ring through reaching to the apex of one of the lateral processes of the cranium in one series of forms, and to the apex of the other process in all other parrots, apart from *Palaeornis*, in so far as I know, including the Owl Parrot (*Stringops*).

The mandible of *Palaeornis docilis* (Plate XL, figs. 4 and 5) has the usual broad U-shaped form found in the case of this bone among parrots generally, and, as is always the case, it is highly pneumatic. Beyond the articular extremities its upper, free margin is thin and sharp all the way round. Relatively speaking, its symphysis is not as deep as it is in the macaws (*Ara*) or in many other parrots. Viewed directly from the front, its free dentary margin forms in outline another U, the open part being above. The lower ramal border is slightly thickened, while the articular ends are truncated above in the downward direction from before backwards. Here each shows the peculiar, shallow, antero-posterior facet for articulation with the *quadrate* of either side. On the upper aspect, posterior to either one of these, is a large, *pneumatic foramen*, and occasionally a smaller opening of the kind exists in front of it. In *Ara chloroptera* the mesial

\* Shufeldt, R. W.: "Myology of the Raven," London, 1901, p. 28, fig. 7, and other figures.

aspect of either ramus of the mandible is pierced in numerous places by these air-holes, and there may occur other small ones on the outer surface.

The *sclerotol platelets* of an eyeball are comparatively rather small, and they differ from each other but very little in size; otherwise they do not present anything beyond their usual ornithic characters.

Upon comparing the *hyoid arches* with the descriptions and figures of those given in Mivart's paper, cited above, I find that this skeletal portion of the tongue in *Palaeornis* comes nearer to the corresponding parts of those structures in *Nanodes discolor* than to those of any other species there described. Especially is this observable in the short *entoglossum* in these two species; but then there may be other parrots with the osseous parts of the tongue still more like those bones in *Palaeornis*; and doubtless there are, for *Nanodes discolor* may not be particularly near our present subject in other respects, in so far as I am aware, though it may be.

The *glosso-hyal (entoglossum)* is notably short in *Palaeornis* in the antero-posterior direction, while it is composed of two separate pieces, as I believe it is in all *Psittaci*. Either one of these is pointed posteriorly, and supports an oblique enlargement distally. They only meet mesially at a minute point in the middle line somewhat posterior to their middles. The *basihyal* is anteriorly elongated, and supports, upon either side, the peculiar forward-projecting, spiculiform processes seen on this element of the skeleton of the hyoid in so many birds of this group. *Urohyal*, which is not very long, is co-ossified with the *basihyal*.

The *ceratobranchials* are long compared with the other elements (hypo-branchials of Mivart), while the *epibranchials* (ceratobranchials of Mivart) are very short and thick, terminating posteriorly in fine, short, hair-like cartilaginous terminations. As taken together, the *thyrohyals* are straightish, not especially elongated, and present scarcely any upward curvature.

I made no careful study of the ossifications of the *larynx*, the *trachea*, or the other parts of the air-passages; but they do not seem to present any very striking differences, in so far as they are concerned, when contrasted with what we find in other ordinary parrots; but when I say this I do not desire to have it understood that it would be a profitless task to study and compare these parts, for it would most assuredly be both important and interesting, and would have been undertaken here had I had the proper material for comparison.

*Of the Axial Skeleton.*—*Palaeornis docilis* agrees with *Psittacus erithacus* and *Lorius flavopallatus*, and doubtless with other parrots, in having nineteen free vertebrae between the skull and the pelvis. This number, however, is not found in this cervico-dorsal region of the column in all *Psittaci*, for in *Conurus carolinensis* there are eighteen, and but seventeen in the representatives of the genus *Ara*.

Mivart has so minutely described the several vertebrae in this section of

the spine for *Psittacus erithacus* and *Lorius flavopalliatu*s that it would be quite superfluous to give a detailed description of these bones here for our present subject. Taking these bones, vertebra by vertebra, the differences are not so very great, though there are, doubtless, specific, as well as perhaps generic, differences to be found in them. In my own published papers on the osteology of the *Psittaci*, cited above, still further descriptions will be found of the vertebrae, as they are found to be in still other forms, as the cockatoos, *Conurus*, and the macaws.

In *Palaeornis* the *allas* has the articular cup entire, and there is a conspicuous process extending backward from the centrum. On the *axis* the *odontoid process* is extremely minute, while the haemal spine, as is likewise the case in the *third cervical vertebra*, is prominently developed. The "carotid canal" is seen to be open, and is only to be observed on the sixth, seventh, eighth, and ninth cervicals; these, including the tenth cervical, are all without neural spines, while their spine-like pleurapophyses are not very long.

*Thirteenth and fourteenth cervical vertebrae* support well-developed ribs of good length, the first being half as long as the second, while neither bear unciform appendages.

The *five dorsal vertebrae* are all separate bones, their neural spines being low, and they interlock with each other at their upper anterior and posterior angles. Only the fifteenth and sixteenth possess haemal spines, while the broad transverse processes on their dorsal aspects develop spine-like metaphyses that reach across from one vertebra to another.

The *ribs*, which are well shown in Plates XL and XLI, are rather delicately formed, and all possess epipleural or unciform appendages, those on the last pair being small. Each pair articulates with a pair of costal ribs reaching to the sternum. This is not the case with the costal ribs or haemapophyses of the first long, thin pair of pelvic ribs, which latter entirely lack epipleural processes. Posterior to this pair of ribs there is another pair, which last are aborted, short, spiculiform affairs, thoroughly ankylosed to the ventral surface of the ilium on either side.

In *Amazona leucocephala* the dorsal ribs are stouter than in *Palaeornis*; the last pair bears no unciform processes, and the long, slender haemapophyses of the only pair of pelvic ribs reach the costal border of the sternum to articulate on the facets there for them.

*Ara chloroptera* has very broad ribs in the dorsal region, and their flat and broad epipleural appendages develop in mid-series a descending process from the postero-inferior angles. In this macaw the first pair of cervical ribs are short, and the elongate second pair have small unciform processes upon them.

Thus it will be observed that important differences exist with respect to the cervical and dorsal ribs in the various genera of parrots, and these

should be more carefully and extensively studied by ornithotomists. The few notes I have given here upon them should be compared with descriptions of mine in former papers for other species of the *Psittaci*, and more especially with Mivart's figures and descriptions for *Psittacus erithacus* and *Lorius flavopalliatius*.

When we come to compare the *pelves* of different parrots, we soon observe that there is considerable uniformity in the matter of their morphology, with respect to the various species mentioned in this paper. To this statement *Palaeornis* forms no exception: *Conurus carolinensis* is not far off, and this is probably true for a good many other species of parrots (see Plate XLI, fig. 7.)

Viewed from above, the *pelvis* of *Palaeornis docilis* shows the anterior rounded and emarginated borders of the ilia, and the rather elongate, concaved surfaces of these bones between these borders and the cotyloid cavity upon either side. These bones do not meet in the middle line in this region, while they do meet and form an osseous union with the crest of the sacrum. Posteriorly, the ilio-neural canals are entirely sealed over, and but few foramina are found to exist between the diapophyses of the *uro-sacral vertebrae*. All this formation gives a very smooth and unbroken appearance to the dorsal aspect of the pelvis of this and other parrots, which is quite characteristic of this bone in the case of other members of the group.

On lateral view, it is seen that the *obturator foramen* is, as a vacancy, almost continuous with the *obturator space*; the *ischadic foramen* is rather large and subelliptical in outline. Another feature of note is the pointedness and elongation of the ischium in the posterior direction, the distal apex of this bone of the pelvis coming in contact with the upper margin of the long, slender pubic element behind. As a "notch," the ilio-ischiadic one is hardly worthy of the name; in other words, scarcely any mark of differentiation on the posterior pelvic border exists at all to define the meeting of the ilium and the ischium. We know this "notch" is very pronounced in the pelves of some birds.

There are *six* free *caudal vertebrae*, the transverse processes of which, all to those of the ultimate one, are rather spreading, and not very markedly bent ventrad. To these is to be added a triangular *pygostyle* of corresponding proportions with a blunt-pointed apex.

*Amazona leucocephala* possesses but *five* free caudal vertebrae, and the pygostyle differs in form entirely from that bone in *Palaeornis*, for it is of a quadrilateral outline in the former bird, with a thickened posterior border, and, moreover, it is pierced from side to side at its antero-inferior angle by a round foramen. In the specimen before me, there is also a deep little pit in the lower part of the posterior margin.

Curiously enough, *Ara severa* has but *four* free caudal vertebrae, and the rather large pygostyle is inclined to be somewhat pointed superiorly. *Ara*

*chloroptera*—the Red and Blue Macaw—is entirely at variance with this again, for it has five very large caudal vertebrae, and, for a parrot, an unusually large pygostyle, which is drawn out superiorly into a point, while it exhibits the thickened hinder border, the foramen, and the pit found in the pygostyle of *Palaeornis docilis* as described above. In this macaw, too, the last two *uro-sacral vertebrae*, thoroughly anchylosed with the others, are found beyond the iliac bones of the pelvis. In this big parrot also we find the ilio-ischiadic notches on the posterior pelvic borders to be quite prominently defined, which, as I have said, is not usually the case in this bone among the *Psittaci*.

Passing to the bones of the *shoulder-girdle* we are to note that, although the *os furcula* is completely developed, it is nevertheless by no means a strong bone. It has the U pattern in outline and lacks a hypocleidium, while it is greatly compressed throughout its extent. This compression is in the antero-posterior direction below, and transversely for the clavicular limbs above, including the superior heads of the bone, each one of which latter exhibits considerable expansion whereby a thin, flat surface is produced—a surface which, when the *os furcula* is duly articulated, is pressed snugly against the coracoid of the same side, touching the scapula posteriorly, thus ensuring the formation of a completed *foramen triosseum*.

Cockatoos, macaws, and representatives of the genus *Amazona* and numerous others, possess a clavicular arch more or less like what is found in *Palaeornis*, while, in some other parrots, the bone is more or less imperfect below or else very rudimentary, as in *Calyptorhynchus*; in *Ara chloroptera* the *os furculum* is, while much flattened, strong and complete.

*Palaeornis* possesses a neat pair of *scapulae*, each bone being rather short and small when compared with the size of the bird. One of these scapulae closely resembles in form the blade of a scimitar, being thin, sharply pointed posteriorly, curved, and lacking in any angle on its mesial edge, where it is seen to occur in the scapula of many other species of birds. Its head forms about one-third of the articular surface of the glenoid cavity for the head of the humerus.

The *coracoids*, when articulated as in life, are in contact with each other in the coracoidal grooves of the sternum. In *Ara* the contact is quite extensive. At its sternal extremity the *coracoid* of *Palaeornis* is considerably expanded, and there is developed at its infero-external angle, or rather just above it, the process—here quite conspicuous—which is found in the same locality in representatives of other groups of birds widely removed from the *Psittaci*. The coracoidal shaft is straight, stout, and smooth, while the enlarged upper end of the bone is peculiarly excavated on its mesial aspect just below the summit. In *Ara chloroptera* this excavation is very extensive, forming a striking feature of the bulky head of the coracoid of that bird. At its base occur numerous pneumatic foramina. I may

say, in passing, that the *scapula* of this macaw is remarkably short and considerably expanded at its distal extremity, and the upper parts of the clavicular heads are pneumatic, with the foramina in plain view at either posterior apex of the bone. Indeed, in these large parrots all the bones of the pectoral arch or shoulder-girdle are more or less pneumatic, as is nearly all the rest of the skeleton.

Although it does not show as much as I should like, still a fair idea of the form of the *sternum* in *Palaeornis* may be gained from Figs. 6 and 8 on Plates XL and XLI of this paper. It presents all the average characters of this bone in the parrots generally, and I have compared it with that bone as it occurs in quite a number of species and genera. Considerable depth and marked thinness are two of the principal features seen in the carina or keel of the bone, which is so extensive that it not only springs from the entire length of the body of the sternum beneath, but projects anteriorly to a large extent, and it is here that its greatest depth is seen. On either side there is a raised welt descending directly downward from the coracoidal groove to the raised pectoral muscular line, which, as usual, runs forwards and backwards on the side of the keel. The *carinal angle* is broadly rounded off, constituting a striking feature in the sterni of all parrots. A conspicuous *manubrial process* projects almost directly upwards; it has a flat, triangular surface in front, and is fashioned posteriorly to form a part of the articular area for the coracoids. The groove for the accommodation of these bones is deep and narrow, the articular surface in them being continuous.

As in most *Psittaci*, the *coracoidal processes* are greatly reduced, being mere low, triangular elevations of no great proportions. Back of them, on either side, we find the six transverse facets for the costal ribs. The body of the sternum of this parrot is shortish as compared with its width, and notably more so as compared with the shape of the body of the bone in the macaws (*Ara*). Superiorly, it is deeply concave and correspondingly convex on its ventral aspect. Its xiphoidal or posterior margin is the widest part of the bone, being very slightly convex outwardly; thin, notwithstanding that it is defined by a perceptible thickened edge on its ventral side, and withal entire—that is, never presenting any “notching” whatever.

On either side of the carina, and well within this posterior border, there is to be found a subcircular foramen of some considerable size. Along the anterior three-fourths of the line of the keel or median line, on the dorsal aspect of the sternum, are to be noted numerous pneumatic foramina, and similar air-sac apertures of no great size pass from the anterior termination of this median row, along the side of the bone, as far back as points opposite the last articulations of the ultimate pair of costal ribs.

All the big macaws (*Ara*) have the xiphoidal foramina comparatively much larger than we find them in *Palaeornis*, and the pneumatic foramina

on the dorsal aspect of the bone, while practically found in the same localities, are far more numerous and more abundant. These foramina are almost entirely absent in the sternum of my specimen of *Ara severa*, and on the right-hand side of the same bone the elliptical xiphoidal foramen, although completely closed in posteriorly, the postero-mesial angle of the outer portion is merely in contact with the postero-external angle of the mid-xiphoidal portion. On the left-hand side the hinder margin of the foramen is entire, with a width of a little more than a millimetre.

Sometimes the xiphoidal foramina are entirely closed in, and this is the case in the sternum of a skeleton of *Cacatua leadbeateri* in my collection. On the dorsal aspect of this sternum, anteriorly, there is formed, mesially, a stout bridge of bone, extending backward from the middle point of the anterior border to a point in the middle line some five or six millimetres posterior to it. Beneath this are found pneumatic foramina, and nowhere else in the bone, apparently. A bridge corresponding to this, only rather shorter, is also found in a sternum of *Amazona leucocephala*, with a circular pneumatic foramen on either side of it. This parrot, too, may have either one or both of the large xiphoidal foramina closed in posteriorly in the same manner as I have just described for a case as found in *Ara severa*; while in addition to this I find here, on either side, a small, circular foramen, situated between the big elliptical one and the keel close to the hinder border of the bone. This bone, however, is often subject to decided variation in species belonging to the same genus; and I find in a sternum of a specimen of *Amazona oratrix* in my collection the aforesaid bridge entirely absent, only one pair of small, irregularly outlined xiphoidal foramina present, while on the dorsal aspect there is a line of minute pneumatic foramina occurring down half the middle line anteriorly, with a few scattered ones behind the anterior border, chiefly near the thickened central portion.

Mivart found, in a specimen of *Lorius flavopalliatius*, the sternum having two—one large and one small—xiphoidal foramina on the right side and none on the left. So it goes; and I believe, when such variations as these are present, there is no hard and fast rule for the presence or absence of these vacuities in the sternums of the *Psittaci*, even in the same species.

*The Pectoral Limb.*—Considerable variation is found here with respect to the pneumaticity of the bones of this part of the skeleton. In *Palaeornis docilis* only the *humerus* appears to enjoy this condition, and this is likewise the case in *Amazona oratrix* and *Amazona leucocephala*, in *Ara severa*, and such cockatoos as I have examined, while in *Ara chloroptera* the entire skeleton of this limb appears to be more or less pneumatic.

Returning to *Palaeornis docilis*, it is to be observed that the *humerus* has a straight, comparatively short shaft, which exhibits some transverse flattening. The *radial crest* is conspicuous though short, and bluntly pointed, while it is bent downward and outward towards the palmar aspect

of the head of the bone. *Incisura capitis* is deeply sculpt as in most parrots, and this renders the tuberculum internum rather prominent. The excavation or fossa in which the pneumatic foramina are found is circumscribed, the crista inferior being short and projecting.

At the distal end the oblique or radial tubercle is particularly well developed as in other parrots, as is the ulnar trochlea on the other aspect of this end of the shaft of the bone.

In the *antibrachium* or forearm the radius is a wonderfully straight bone, while, on the other hand, the *ulna* is considerably bowed, and shows but very faintly down its shaft the papillae for the insertions of the quill-butts of the secondary feathers of the wing. *Carpus* has the two bones found in the wrist of all birds—namely, the *radiale* and the *ulnare*; they require no special description, though doubtless they exhibit some morphological differences in the various species of the *Psittaci* of the world's avifauna.

*Radius* has a length of 4 cms. and the *carpo-metacarpus* of 2·3 cms., the humerus striking an average with a length of 3·5 cms. The main shaft of the carpo-metacarpus is straight and comparatively stout, while that of medius digit is slender and slightly bowed at its proximal third.

For the rest, the skeleton of manus presents nothing exceptionally peculiar, or what I have not elsewhere invited attention to in my previous writings.

In some parrots (*Amazona*, etc.) and macaws (*Ara*), at the distal end of the carpo-metacarpus, on the palmar side, one of the muscular grooves is bridged across transversely with a small bridge of bone, and a knowledge of the presence of this character may, in some instances, help out in making references of fossil psittacine carpo-metacarpi.

*Ara* has the expanded part of the proximal phalanx of medius digit perforated by two foramina, and the vacuities, as a rule, do not occur in ordinary parrots.

Claws do not appear on any of the digits of manus.

*The Pelvic Limb.*—There are some good distinctive characters in the skeleton of this limb among parrots, and, as a rule, these are present in the majority of the representatives of the group.

With respect to pneumaticity, it seems to be restricted to the *femur* in *Palaeornis docilis*, while in the big macaws (*Ara chloroptera*) the bones of the entire pelvic limb appear to enjoy that condition, all to the pedal phalanges. None of the bones of this limb are pneumatic in *Cacatua leadbeateri*, and this may be true of other cockatoos not examined by me.

Returning to the femur of *Palaeornis docilis*, it is to be noted that its subcylindrical shaft is quite straight, smooth, long, and slender. Proximally, the usual characters there seen are but feebly developed, as I find the *caput femoris* small and sessile, and the trochanter major much reduced at the summit as well as on the anterior aspect. It rises not at all above the

smooth summit of the shaft, while there is no evidence of a trochanter minor being present. Distally, the condyles are small, with a very shallow popliteal excavation between them posteriorly, and a not much deeper channel, or rotular channel, as Sir Richard Owen called it, between them on the anterior aspect. As usual, the external condyle is grooved to receive the head of the fibula when the leg bones are duly articulated.

All parrots and macaws possess a *patella* of fair size; and, in so far as I have examined it, I may say that it seems invariably to possess a flat area proximally, with a continuous sharp edge for the sides and below, and an elevated surface posteriorly, the anterior surface being moderately convex. Occasionally we may find exceptions to this; for in *Amazona leucocephala* the patella is very small, and its superior surface exhibits more of a concavity. This species has a femur which, while somewhat larger, nevertheless closely resembles that bone in *Palaeornis*.

In our subject, the *tibio-tarsus* is as straight as its femur, and its shaft is, comparatively speaking, equally slender.

The *cnemial processes* are both greatly reduced, and proximally they may be said to be about on the level with the summit of the shaft.

Distally, the condyles are but moderately developed, and, as in all parrots and macaws, the *outer condyle* is notably smaller than the inner one. At the lower third of the bone in front, the tendinal groove is short and shallow, and as in *Psittaci* generally, it is twice spanned by tendinous bridges to hold the tendons in the aforesaid groove, the upper one being obliquely attached, with its outer extremity the lower. In *Amazona oratrix* the tibio-tarsus is considerably compressed from before backwards, giving it the appearance of some fossil specimens of this bone.

The "fibular ridge" occupies its usual site, the *fibula* itself being a feebly developed bone, and when articulated extends only a short distance below this ridge as a fine, hair-like prolongation. Macaws, in which the fibula is comparatively much stouter, have the bone even shorter than in *Palaeornis*, for it does not extend below the fibular ridge at all. This is likewise the case in *Amazona oratrix*, and in probably other *Psittaci*, while in the entire assemblage it is a short bone, though one sometimes well developed for what there is of it.

Coming to the *tarso-metatarsus* there is first to be noted its extreme shortness when compared with the other bones of the thigh and leg. For example, in *Palaeornis docilis*, where the femur has a length of 3.1 cms., the tibio-tarsus 4.3 cms., the tarso-metatarsus possesses a length of but 1.6 cms. Other *Psittaci* exhibit similar proportions upon measuring these several bones. Its distal extremity in *Palaeornis docilis*, and in other parrots, cockatoos, and macaws is much compressed from before backwards, and much spread out transversely. This is due to the conformation of the trochlear prolongations, which are fashioned to adapt themselves to the

zygodactyle arrangement of the toes in this and other *Psittaci*. The *hypotarsus* at the postero-proximal extremity is extremely narrow from above downwards. In macaws this is even more markedly the case, and in these birds it has but one large, central perforation for the passage of tendons, while in *Palaeornis docilis* there are two very distinct small ones.

In *Amazona oratrix* this perforation is also single, as it is likewise in Leadbeater's Cockatoo (*Cacatua leadbeateri*).

*First metatarsal* or "accessory metatarsal" for *hallux digit* in *Palaeornis* small, and, as a matter of fact, is not especially large in the big macaws. As to the *phalanges of pes*, they offer nothing of unusual character beyond what I have already described for the *Psittaci* generally in previous papers of mine, cited above. That these birds all possess zygodactyle feet, through the reversion of the fourth digit, is a fact long known both to systematic ornithologists and to avian anatomists.

#### CONCLUSIONS.

In so far as the osteology of *Palaeornis* goes, it would seem that it tends to support the views of those taxonomers who claim that the birds of this genus, together with other genera, constitute a subfamily—*Palaeornithinae*. This subfamily Garrod placed in a family *Palaeornithidae*, while R. Bowdler Sharpe relegated the same subfamily to the family *Psittacidae*, which is probably nearer the case than what the first-named classifier seemed to believe to be their position in the system.

This entire group of birds stands much in need of researches upon its morphology, and particularly its osteology; and until this is far more exhaustively done than it has been up to the present time (January, 1915), we shall not be able to appreciate the natural affinities of many of these birds which are now classified upon a few external characters, and, in only a limited number, only too few internal structural ones.

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EXPLANATION OF PLATES.

(All the figures in the three Plates are the work of the author, made direct from the specimens shown.)

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PLATE XXXIX.

PALAEORNIS DOCILIS; half natural size.

PLATE XL.

(All the figures in this Plate, as well as those in Plate XLI, are of natural size, and all illustrate the skeleton of the specimen shown in Plate I.)

FIG.

1. Right lateral view of the skull; mandible removed.
2. Skull from above; mandible removed.
3. Skull from below; mandible removed.
4. Direct view of mandible from above.
5. Semi-oblique view of the mandible from below.
6. Left lateral view of the trunk skeleton; the left pectoral limb *in situ*; and the skeleton of the left thigh and leg.

PLATE XLI.

7. Same as in Fig. 6 of Plate XL, seen from above.
8. Same as in Fig. 6 of Plate XL and Fig. 7 of this Plate, seen upon ventral aspect.